Waterbirds and their habitat on the Clarence River floodplain: a history

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ABSTRACT

At the time of European settlement, the wetlands of the Clarence River floodplain sustained considerably higher numbers of waterbirds than at present. These wetlands were valuable natural resources for the local Aboriginal people with ducks, geese and swans easily hunted using traditional methods. European settlers displaced the local Aboriginal people from the floodplain in the 1800s, although through to the 1960s waterbirds were common food items for local residents with hunting being a popular sporting pursuit. European settlement dramatically altered waterbird habitat through the clearing of native vegetation, the introduction of farming and grazing, and hydrological alteration. The hydrology of the floodplain wetlands was altered initially by manually-constructed shallow drains but later, and more drastically, by a flood mitigation scheme that involved the construction of deep drains and channels affecting not only surface, but also sub-surface, hydrology. The subsequent ecological impacts included a dramatic decline in waterbird numbers and depletion of functional habitat. Only very recently have there been methodical efforts to restore locally important habitat, albeit incidentally to other restoration goals. On-going restoration efforts have focussed on modifying hydrological regimes on agricultural land for the control of acid sulphate discharge and creation of fish passage, although most recently a wetland area was purchased by government for nature conservation purposes.

Key words: waterbirds, wetlands, Clarence River, flood mitigation, drainage, estuary.

Introduction

> *"For feathered game the Clarence had few equals and simply abounded with wild ducks of almost every species, also wild geese, swans and coots. These were to be seen in countless thousands in the different swamps in the river valley."* (McFarlane 1980 p. 39)

Overview

The history of the Clarence River floodplain on the north coast of New South Wales (NSW) is a case study in the ecological impact of human modification of a natural landscape, particularly that of coastal floodplain wetlands. The floodplain's wetlands once supported much larger numbers of waterbirds than at present, but major landscape changes, brought about by human activity since European settlement in the 1830s, led to dramatic ecological changes. A major decline in waterbird numbers followed large drainage schemes of the 1950s onwards, which depleted local wetland habitat, while other factors, such as the extensive clearing of native vegetation, siltation, intensive agriculture, drainage of wetlands, urbanisation, construction of roads and other infrastructure, all contributed to the depletion of habitat and subsequent demise or displacement of waterbirds. Despite the continued pressures of hunting through the 19th and 20th centuries, it seems that most species of waterbirds maintained relatively high numbers until the implementation of the large drainage schemes.

General Significance

Since the first European settlement in Australia in 1788, over half of the country's wetlands have vanished and many of the remaining ones are threatened or degraded (Sainty and Associates 1996). Very few catchments in NSW are completely free of some form of hydrological manipulation (DWR 1990), and the wetlands of the Clarence River floodplain are particularly affected, with 92% degraded by drainage (Pressey 1987). The Clarence River floodplain wetlands are major components of the waterbird habitat of Australia's east coast (Goodrick 1970).

The protection and rehabilitation of floodplain wetlands, habitat for many waterbird species, is a major challenge in Australia (DEH 2007) and globally (Wetlands International 2006). The destruction of these wetlands has been driven by the desire to maximise the productivity of agricultural land, and a common method in this destruction is drainage. Although wetland conversions and alterations have resulted in many benefits to society, the ecological and economic costs have also been great (Good et al. 1999) including the loss of waterbird habitat (Kingsford and Norman 2002).

My aim here is to review the published, historical and anecdotal records to reveal the underlying and inherent challenges of environmental management on the Clarence River floodplain. Competing current and future demands of the natural resource have historical bases and require skilful consideration for the restoration and ongoing management of waterbird habitat. This paper presents and describes historical information that is important for understanding the ecological changes that have occurred on the floodplain. This information is valuable for framing future research, management and restoration projects there.

Materials and Methods

The Clarence River is the largest river in NSW with a catchment of 22,000 km^2 and with a low-lying coastal floodplain of 2,100 km^2 (Williams 2000). The average annual freshwater discharge is approximately five million Megalitres (5 km^3/year) (Pollard and Hannan 1994), which is about half that of the Murray-Darling system (Australia's most extensive river system) (Simpson *et al.* 1992). Two major tributaries, Sportsmans Creek and the Coldstream River connect the main river channel to large wetland complexes adjacent to these tributaries (Figure 1).

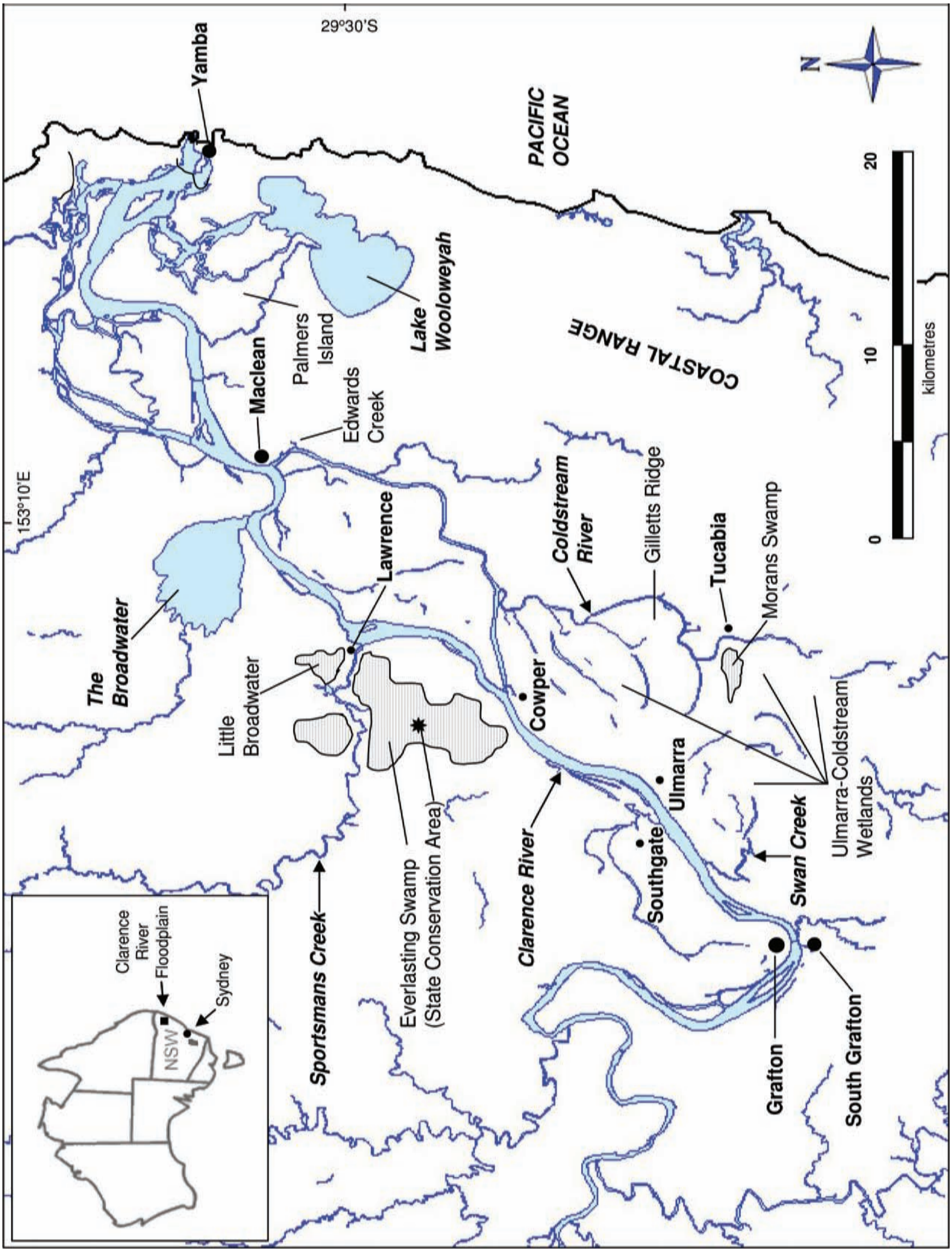

Figure 1. Location of the Clarence River floodplain in north-east New South Wales.

The floodplain (centred approximately 29°35'S, 153°05'E) is a coastal delta featuring a series of wetlands of varying salinities from fresh, to seasonally-fresh, to brackish and to saline, forming habitat for many species of resident and migratory waterbirds. The fresh and seasonally fresh wetlands are the focus of this paper because of their importance as habitat for waterbirds now listed as threatened in NSW (*Threatened Species Conservation Act 1995*). Twenty-two species of migratory waders are frequently recorded in the estuary as a whole (Sandpiper Environmental 2004), and some these species are often recorded in these wetlands. After 1985, many of these wetlands were included under land zoning SEPP 14 (*Environmental Planning and Assessment Act 1979*) as significant coastal wetlands and subsequently given increased protection by the NSW government.

The floodplain's climate is sub-tropical with warm, wet summers and cool, dry winters. Major rainfall occurs in January to April with a mean annual rainfall of 1050 mm, while mean monthly maximum temperatures vary from 29°C in January to 19°C in July, and mean monthly minimum temperatures vary from 19°C in January to 6°C in July (NSW DPI 2005).

Seasonal rises and falls in river levels are punctuated by major flood events of which there have been 71 in the past 166 years (Clarence Valley Council 2007). Flood and rainfall events determine the wetting and drying cycles of the floodplain wetlands, but have been problematic for agriculture and urban areas. The floodplain is underlain by potential acid sulphate soils that can oxidise when disturbed, with the subsequent toxic leachates discharging into waterways and affecting aquatic life by, for example, initiating red-spot disease in fish.

Nearly all of the floodplain has been greatly modified since European settlement in the 1800s, cleared of its native vegetation mostly for agriculture, and now dominated by two major land uses: sugar cane in the lower floodplain and cattle grazing in the upper floodplain. Non-agricultural land is typically used for urban or infrastructure purposes. Most actual and potential high-quality waterbird habitat is located on private agricultural land and wetland restoration efforts are limited by the current land uses, and attitudes and economic considerations of landholders, particularly their dependence on a stable, or at least predictable, hydrologic regime. Since 1997, wetland restoration efforts have had the primary goals of suppressing the oxidation of acid sulphate soils, and the creation or enhancement of fish passage through greater connectivity within and between waterways. Waterbird habitat has been incidental or of secondary consideration in these efforts.

The published, historical and anecdotal records that form the basis of this paper were collected from 2005 to 2008. Most historical publications and documents were retrieved from the Dixson Library of the University of New England and the State (Mitchell) Library of NSW in Sydney. The Clarence River Historical Society in Grafton housed historical photographs and records including old newspapers and the records of the Clarence Valley Field Naturalists Club.

There are few records of waterbirds on the Clarence before the 1950s. Two important local accounts of the 1800s, the 1886 lectures of Thomas Bawden, and the notes of John McFarlane written from 1910 to 1915, were not published until the late 20th century (Bawden 1979; McFarlane 1980), courtesy of local historical societies. Similarly, the letters of the 1860s naturalist, John MacGillivray, were not published until the 20th century, but were presented in another author's publication (Iredale 1937).

Personal communications were a valuable source of historical information for this paper, and were offered very freely on many occasions at many locations in the Clarence district during the course of the research. All quotations from personal communications are used with the written permission of the person quoted. Two local landholders, Roy Bowling and Terry Harrison, had vivid recollections of waterbirds and the floodplain back to the 1930s. They also maintained detailed, local, family oral histories, passed down to them from preceding generations, extending back to the 1800s.

Quantifying the subjective descriptions of abundance of waterbirds from the 1800s is difficult, if not impossible, but it becomes meaningful if we know with what they were being compared. It seems likely the comparisons were with waterbird abundance from around Sydney, Newcastle (and the Hunter River region), and other agriculturally-developed areas of NSW, as the various sources were familiar with these areas. Consequently, their descriptions give the Clarence River floodplain waterbird community as being of historic importance as the most abundant on the State's accessible coast at the time.

The nature of history is that it sometimes conveys information that is unverified or unverifiable. In this research, anecdotal information was cautiously but generally accepted, especially when similar anecdotes were imparted independently. Leith Martin is the oldest surviving member of the Clarence Valley Field Naturalists Club of the 1950s, and as he remarked, "there is no-one left alive to contradict what I say, so whatever I say must be true!"

The Pre-European Landscape: Traditional Aboriginal Use and European Discovery

The Pre-European Landscape

The landscape of the pre-European Clarence River floodplain is not well documented but its appearance can be inferred from historical records of the early European settlers (Bawden 1979; Farwell 1973; McFarlane 1980), surveyors' maps (e.g. Wilson 1842 in McSwan 1992) and archaeological records (McBryde *et al* 1982).

The river supported a riparian zone of tall, dense sub-tropical rainforest referred to as 'brush', varying from a narrow fringe at the bank extending possibly up to a kilometre or more from the river's edge at other places. Such forest extended along not only the main river channel but also secondary channels and tributaries, often overhanging the water to the extent that the boats of early European visitors had difficulties in negotiating the channels (McSwan 1992). Beyond the riparian zone were wetlands of varying sizes up to more than 1,000 hectares with expanses of open water, and marsh vegetation that varied seasonally and with changing water depths. Fringing these wetlands, and forming the matrix of the floodplain, were open and closed *Casuarina*, *Eucalyptus* and *Melaleuca* spp. woodlands and forests.

Prior to European settlement, Aboriginal people probably occupied all parts of the floodplain at various times. They undoubtedly modified the landscape, for example with fire and hunting (McBryde *et al.* 1982), although impacts on wetlands were probably negligible given that hunting and gathering was undertaken to feed relatively few people, and wetlands were unlikely to have been burned.

Aboriginal Use

> *"… they were located in the midst of plenty … Food in abundance was attainable without toil and with little energy … The swamps provided an endless variety of game including ducks, geese, swans and coots. The rivers and creeks were teeming with fish."* (McFarlane 1980 p. 14)

Prior to the arrival of Europeans, the floodplain was undoubtedly a valuable resource for the local Aboriginal people. The river (Aboriginal name = *"Boorimba," "Booryimba," "Breimba"*) was a boundary between the nations of Bundjalung (in the north and west), Gumbaingirr (in the south and west) and Yeagl (in the east) (Beaver 2007; McSwan 1992). There are few records of traditional Aboriginal exploitation of waterbirds on the floodplain and anecdotal information has passed from living memories (Lisa Appo, pers. comm.). Nevertheless, waterbirds were an obvious food resource (McBryde *et al*. 1982), and the few recorded observations of the early European visitors and settlers in the mid 1800s vividly attest to traditional Aboriginal hunting of waterbirds being common place.

Waterbirds such as ducks, geese and swans appear to have been commonly hunted animals. While hunting appears to have been a male occupation undertaken across the floodplain, women were recorded as undertaking the collection of the eggs of 'swan and ibis' in the Edwards Creek wetland (near the present town of Maclean) (McSwan 1992), a practice almost certainly undertaken at other floodplain wetlands.

McFarlane (1980 p. 15) described his personal observations of how, traditionally, Aboriginal people on the floodplain established camps of about 50 people, typically in "dense scrub" and close to water. These camps shifted every "couple of weeks," but "seldom more than a mile," as the ease of obtaining food decreased at each site, a process referred to as "working the swamps." While Aboriginal people were often observed swimming, *"I have never seen an aborigine that could not swim and swim well"* (McFarlane *op cit* p. 20), bark canoes seem to have been important in accessing the wetlands for hunting (Figure 2), as McFarlane (*op cit* p. 24) observed:

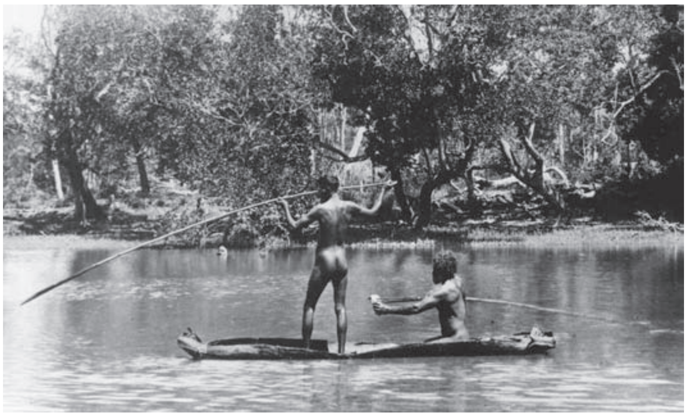

Figure 2. Aboriginal men hunting and fishing from a bark canoe in an estuary of the New South Wales north coast ca. 1900. (From the Thomas Dick photographic collection, courtesy of Lisa Apo, NSW NPWS)

> *"The canoes were made of a sheet of stringy-bark gathered at both ends and tied securely. A couple of cross sticks served to keep them from closing in. The bottom was round and the canoe was consequently easily upset. It would carry two or three blacks and was propelled by a stick about five feet in length flattened at each end. This was held in the centre and a stroke would be paddled on each side alternately which caused the canoe to travel at a fair speed and with very little exertion. The canoes would float in a few inches of water and were brought into service on the large swamp areas when in quest of ducks, geese, swans and other water fowl. Bushes were erected in the bow of the canoe and let sail in the direction of the game. An armed black would be in charge and being hidden by the bushes his approach would not create any alarm. When within easy distance the waddies were thrown with unerring accuracy and the game bagged. One great advantage in the canoe was that there was little time or labour required to construct it and in addition it could be carried from one place to another without difficulty. They were indispensable on the Lower Clarence for reaching the different islands which contained dense scrub and abounded in game."*

Farwell (1973 p. 112) also described the use of canoes on the Clarence and its tributaries:

> *"Even in times of flood they crossed rivers and creeks in fragile canoes made from a single sheet of treebark, moving at speed by paddling with tree limbs or blunt segments of wood."*

Interestingly, later Europeans developed small boats of similar dimensions and used them in a similar way for hunting in wetlands (see later in text). Aboriginal hunting of waterbirds was not undertaken only with canoes, as Farwell (*op cit* p.111) describes:

> *"the brimming channels of the Big River, the swamps and lagoons all carried wildfowl in immense quantities: magpie geese, wild duck, teal, shags, cranes* [probably herons], *ibis, brolgas, all of which were cunningly panicked into flight towards some pre-arranged ambush among reeds and shrubs."*

These 'ambushes' would have consisted of armed men, including those with nets (see Figure 3). Such nets, made from the spun fibres of reeds, vines and trees, were

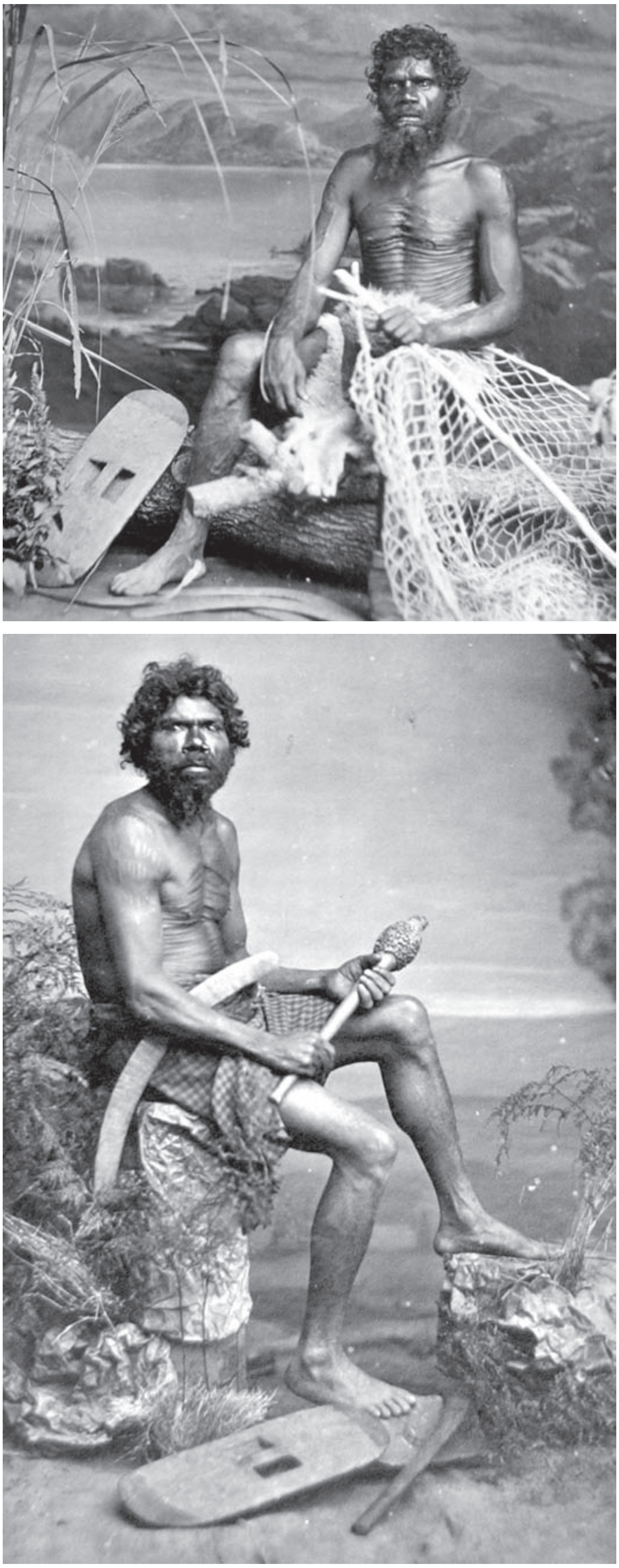

Figure 3. Studio portraits of Aboriginal men of the Clarence River area ca. 1873 with hunting equipment, including what is probably a bird net (Moya Smith, pers. comm. 2008, WA Museum). (Photographs by J.W. Lindt, Grafton. Courtesy of the Clarence River Historical Society)

deployed widely among traditional Aboriginal people in southeast Australia (Satterthwait 1987), and could be up to 18 metres in length, took up to about two years to construct, and were capable of catching up to 100 ducks. They were therefore likely to have been considered precious pieces of equipment. Bundock (1894, in Farwell 1973) describes the hunting of kangaroos with such nets in the Clarence region, which indicates they were indeed made of sufficient strength to be capable of catching large birds such as waterbirds.

Upon the arrival of Europeans and interaction with them from the 1830s onwards, traditional hunting equipment was sometimes replaced with firearms. McSwan (1992 p. 5) describes when the surveyor Greaves came to the Clarence to lay out the town of Maclean in 1862: "*when the land was still in a pristine state, his party camped for several weeks, and he said*

> "*the aboriginals* [were] *very friendly, so much so that I lent them my shotgun and they kept us supplied with pigeons, brush turkeys and ducks as well as plentiful supplies of fish.*""

However, traditional hunting practices on the floodplain decreased over the decades following the arrival of European settlers.

European Discovery

The mouth of the Clarence River was observed by the British naval explorers, James Cook in 1770 and Matthew Flinders in 1799, the latter naming the entrance "Shoal Bay", but neither realised it was a river (McFarlane 1980). The European discovery of the river is credited to Richard Craig, who as an escaped convict, passed through the region in the late 1820s journeying from imprisonment in Moreton Bay in the north to Port Macquarie to the south (Bawden 1979). Upon reconnection with European settlement, and subsequent pardoning, he reported the location of the river as one supporting large stands of valuable timber. This inspired timber merchants to dispatch exploratory ships from Sydney to what was referred to as the "Big River". Discovery trips included that of the first steamer to enter the Clarence, the "*King William*" in 1839. Records of this trip include what is probably the first written record of waterbirds on the river:

> "*after procuring a variety of game (with which the Big River abounds) during our residence on it – such as Swan, Duck, Teal, Water Hen, Pigeon – all of which were excellent when cooked and of which we heartily partook and the thoughts of which were fresh in the recollection of all of us …*" "*10 black natives came on board and amused themselves and those on board by doing a corroborrah* [sic] *for one and a half hours.*" (Williams 1839)

Following discovery, settlement on the floodplain was rapid as were the ensuing social and ecological changes.

Landscape Change I - European Settlement

> "*The transformation of a wilderness of bush to almost paradise on earth was a work to which many elements had to contribute*" (McFarlane 1980).

1830s to 1850s: The Cedar-getters and Pastoralists

European settlement of the Clarence River region was rapid following reports of the existence there of large tracts of rainforest ("brush") containing Red Cedar *Toona ciliata* and Hoop Pine *Araucaria cunninghamii*. By 1838 Red Cedar timber was being shipped to Sydney but by about 1842 *"the best of the cedar had been cut out"* (Bawden 1979), indicating that the integrity of the rainforest had already deteriorated by this time. However the cedar-getters had left a legacy including the establishment of a timber industry (which soon turned to the eucalypt forests), establishment of shipping services to the region, river transport and trade, Aboriginal-European contact, and establishment of about 20 urban centres including "The Settlement" which was later renamed Grafton.

During the 1840s and 1850s squatters established large pastoral operations (stations) on the floodplain and in the region generally, on land leased from the government. Here they maintained large numbers of sheep and cattle. For example, in the 1840s Swan Creek station, 40,000 acres (16,000 ha) on the southeast of the floodplain, supported 12,000 head of cattle (Bawden 1979), while Yulgilbar Station upstream from Grafton had 30,000 head of sheep at this time (McFarlane 1980 p. 61). While sheep are no longer grazed there in large numbers, the capability of the floodplain to graze cattle remains highly regarded in modern times (pers. obs.) ever since being recognised as such in the 1840s, as McFarlane (*op cit*) reflected:

> *"Imagine the swamps of Ulmarra, Southgate, Lawrence and Woodford Island included in cattle stations. In the summer this class of country would fatten a beast to the acre."*

The potential ecological effects of the rapid introduction of such numbers of large herbivores into the area now seem obvious, but any effects that occurred at that time were not measured and not commented upon in historical literature, and are now indiscernible given the more dramatic ecological changes that have followed. The highly profitable grazing practices of the squatters required little land clearing. It seems likely that this pastoral period had relatively little impact on local waterbirds and their habitats, if for no other reason than the low resident human population in these areas. Supporting this notion was that the squatters' inability or lack of desire to clear the land was held in disdain (McFarlane 1980), no doubt accompanied by unease with the growing concentration of property and wealth among relatively few people.

Bird Stuffing

In his 1886 lectures, Bawden (1979) refers to *"the Bird Stuffer's residence"* in South Grafton in 1841, and a*"box of stuffed birds"* in 1844, suggesting a professional taxidermist was resident at this early stage of settlement. In 1857, the professional specimen collector, James Fowler Wilcox, took up residence in South Grafton and was directly or indirectly responsible for the collection of biological specimens, including local waterbirds, and their supply under contract to museums, exhibitions or third parties within Australia and internationally. In the 1800s there was a large international trade in bird plumes (mainly for hats), with the most sought-after plumes being the breeding plumes of egrets and herons (Peter Jarman, pers. comm.). Local specimen collectors were likely to have been involved in this trade.

Effect on Aboriginal People

This period also saw a range of interactions between the Europeans and local Aboriginal people, and the few records of these interactions at this time provide an insight into the traditional practices of the local people as previously described. However, these interactions ranged from friendly trade and social exchange to brutal conflicts punctuated by spearings, shootings, reprisals, and bloody and unprovoked massacres (Bawden 1979; McFarlane 1980). A process of displacement had been initiated and this soon accelerated.

1860s to 1950s: The Free Settlers – Small Farms, Displacement and Land Clearing

Land reforms of the 1860s in NSW were based on "a long-held English tenet that a 'civilised' society was settled and agricultural, while an 'uncivilised' culture was characterised by nomadic herding and hunting" (Waterhouse 2006).

> *"…. the passage of the 1861 Free Selection Act had the effect of bringing to the district a large number of settlers who soon picked the eyes out of the different stations that were located near the navigable portions of the river. The swamp lands and the water frontages quickly passed into the hands of the selectors which rendered the leasehold lands of little value ..."* (McFarlane 1980 p. 61)

The 1861 *Free Selection Act* was the catalyst for a large influx of European "free settlers" (*i.e.*, not convicts) onto the Clarence from 1862 onwards. Initially, Scottish migrants dominated this free settlement process (with lesser numbers of Irish, English, Germans and other Europeans). These people were often the poor descendants of Scottish highlanders who had been economically and politically displaced by "The Clearances" process there in the 1700s (McSwan 1992). Ironically, these new settlers presided over the displacement of Aboriginal people from the floodplain.

> *"The intrusion of the white man was a sorry day for the blacks. Their hunting ground, together with their accustomed food was quickly destroyed."* (McFarlane 1980 p. 17) *"Not only* [that] *… but the treatment meted to them has been anything but humane. In many instances it has been absolutely cruel."* (McFarlane 1980 p. 4)

However, this displacement was not necessarily hostile. Possibly reflecting cultural differences between Aboriginal groups, or between the attitudes of settlers, or both, the alienation of Aboriginal people from their land differed within the region. The settlers of the floodplain displaced Aboriginal people by clearing the forests, erecting fences, growing crops and living on permanent dwellings on their farms, thereby *"effectively depriving aborigines of their traditional use of the land to the* *same extent as shotgun and poison did on the Upper River"* (McSwan 1992 p. 4). Interestingly, some Aboriginal people retained a traditional lifestyle on the floodplain into the early 1900s living in bark huts and rock shelters on nearby elevated sites (*e.g.* at the hill area of the town of Maclean), and hunting and collecting on nearby wetlands (McSwan 1992 p. 7).

Small farms

The 1860s was the period in the Clarence region for establishing a society based on small-scale agricultural holdings, an idea that persisted with European Australians "at least well into the twentieth century" (Waterhouse 2006). In the Clarence this meant the transformation of riparian rainforest, woodlands and wetlands into small farms. The selectors bought, at low cost from the government, blocks of land in 40 to 50 acre (16-20 ha) allotments and multiples thereof. With the red cedar gone, the remaining rainforest was of little value to the settlers, acting only as an indicator of the more fertile soils. Therefore, selectors chose rainforest sites first, and by the end of this decade most of this 'solid brush' on the river bank land from Grafton to Palmers Island was cleared (McSwan 1992 p. 24).

> *"The rich brushes in the valley of the river have long since disappeared. Unfortunately we did not realise the treasure we had in the vast quantities of rosewood, tulip, beech, teak, bean, silky oak and ash that were everywhere to be found. Had these been available today they would be worth quite as much as the land itself. Scarcely any of those timbers ever found a market but were reduced to ashes in the clearing process.* (McFarlane 1980 p. 61)

Figure 4 shows the cleared landscape of the floodplain.

The impact of the loss of surrounding vegetation may have been significant for waterbirds as well as the other constituent fauna of that 'brush'. Roost and nesting sites would have been depleted (e.g. hollows for many ducks and trees for colonial waterbirds) while refuges from predation also disappeared. Of course, this could have suited other species such as Brolgas, some ducks and swamphens that prefer more open habitat including wet pasture.

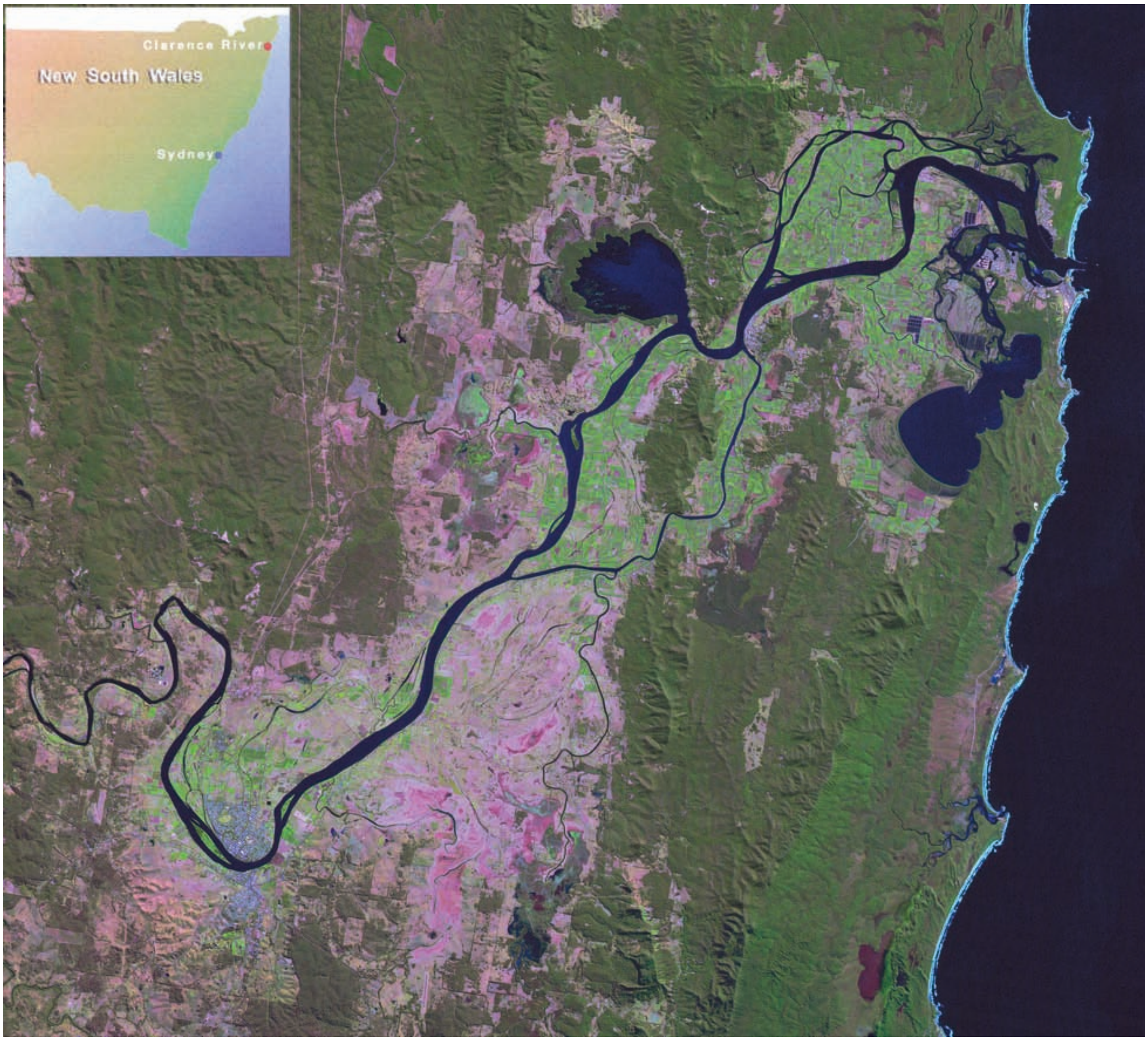

Figure 4. The Clarence River floodplain 2002 (Spot Image) showing a landscape mostly cleared of native vegetation (in lighter shades). (Courtesy of Clarence Valley Council)

> The small farms initially produced cattle, sheep, wool, tallow, timber, maize (corn), wheat and cotton. Sugar cane, dairying and pigs soon followed but by the end of the 19th century the floodplain landscape was one dominated by *"dairy herds, maize, canefields and a teeming population* [of Europeans]*"* (McFarlane 1980 p. 40).

The boundaries of the settlers' blocks were established with cursory consideration, and little understanding, of natural features. This was of particular significance with respect to hydrological issues as the small-scale farmers tried to cope with the effects of floods and tides. The nature, methods and evolution of farming practices on the floodplain critically affected the habitat of local waterbirds, and agricultural issues remain central to the current management of habitat and the floodplain in general.

Land clearing was not restricted to the floodplain. Later selectors moved onto the leasehold pastoral runs, on what was the more marginal agricultural land of the upper catchment and proceeded to clear the existing Eucalypt forests by ring-barking and felling the trees for a conversion to grasslands to increase its potential for livestock grazing. As a consequence, these areas became vulnerable to soil erosion following rains and floods, and massive deposits of silt were washed down from these areas in the 1880s and 1890s and deposited into the floodplain wetlands (Roy Bowling, pers. comm.). Soil erosion and siltation rates in the Clarence River catchment remain elevated above natural levels (Matt Foley, pers. comm.). With 34 major floods from 1839 to 1948, and with this process being manifest it is likely that this silt settled in the wetlands and decreased water depths. This process was observed at Morans Swamp where there were once pools up to 10 metres deep that are now less than one metre, and where three floods from 1945 to 1948 each deposited over one metre of silt, as measured by a fence that was buried and rebuilt on each occasion (Roy Bowling, pers. comm.).

Floodplain Farming Life through to the 1950s

Farming life on the small agricultural holdings remained simple and modest for at least 100 years:

> [In 1963] *"I stopped at Southgate where a farmer was using a single furrow plough pulled by a horse. I said "why don't they use tractors?" I realised later they didn't have the money to buy a tractor."* (Ori Pastega, in Lucas 1999)

Despite the relative simplicity, and late adoption of mechanisation and availability of electricity, the farmers were able to sustain themselves often in semi-subsistence lifestyles by growing much of their own food through crops and livestock with regular supplements of wild-caught food, such as waterbirds.

Waterbird Abundance

A common living memory of those who recall their lives on the floodplain from the 1950s and before is the sheer number of waterbirds that were often present. *"The birdlife was unreal, when they flew it looked like a cloud going over the sun"* (Roy Bowling, pers. comm.) and visual comparisons are drawn to the current spectacle of local flying-foxes where over 100,000 individuals may pass overhead. Flight behaviour can alter the impression of abundance (pers. obs.) and unless an actual number is remembered such terms can refer to flocks of as few as 100 birds. Unfortunately there were no accurate counts from before the 1950s but the anecdotal recollections of flocks of ducks in "thousands" and "hundreds of thousands" are entirely credible even though such terms are often used without any counting having been done.

Also indicative of higher bird abundance are the personal recollections and stories from earlier generations about birds and their nests in different areas. The following were noted by local landholders Roy Bowling, Ralph Conners, and Terry Harrison.

- "Acres" of Black Swan *Cygnus atratus* nests are recalled as having been present on many of the wetlands on the upper and lower floodplain (Roy Bowling, Ralph Conners, and Terry Harrison) with the aggregations of nests so dense as to impede the riding of a horse through some areas (Ralph Conners).
- Nests of Black-winged Stilts *Himantopus himantopus* are remembered as being "three to four acres" on the Everlasting Swamp (Terry Harrison).
- Other birds remembered in large numbers are Comb-crested Jacanas (*Irediparra gallinacea*) said to be around 200 in Morans Swamp (on the Coldstream) and similar numbers on the Sportsman Creek when the water lilies were profuse there (Terry Harrison), and even on a small wetland of the Coldstream it was common to see 50 Jacanas (Roy Bowling).
- Magpie Geese *Anseranus semipalmata* were mostly absent from the floodplain from about 1900 to the 1980s (Clancy, 1985), and while their earlier presence is beyond living memory, anecdotes passed on from previous generations suggest flocks might have been from 500 (Roy Bowling) to over 1,000 (Terry Harrison).
- Brolgas *Grus rubicundus* were numerous and widespread around the wetlands and adjoining areas with at least 40 commonly observed at Morans Swamp with *"nests all over the place around Everlasting and other swamps"* (Terry Harrison).
- Latham's Snipe *Gallinago hardwickii* were said to be there in their "thousands" with Pacific Golden Plovers *Pluvialis fulva* also often sighted (Roy Bowling), and although Black-necked Storks *Ephippiorhynchus asiaticus* were commonly observed there is little indication that they were there in high numbers.
- Also remembered in large numbers were Eurasian Coots *Fulica atra*, and Red-kneed Dotterels *Erythrogonys cinctus* were seen at up to 50 at a time, and 30-40 rails (probably Buff-banded Rails *Gallirallus philippensis* (Roy Bowling). The presence of the latter and Latham's Snipe suggests copious amounts of long grass adjacent to wet areas.
- Nankeen Night-Herons *Nycticorax caledonicus* were said to number "about 2-300" in the Tucabia-Ulmarra area when a patch of rainforest still remained there (Roy Bowling).

- Birds of prey were often sighted and prior to 1920 (before living memory), White-bellied Sea-Eagles *Haliaeetus leucogaster* fed on Straw-necked Ibis *Threskiornis spinicollis* or Australian White Ibis or *T. molucca*, which at that time nested at ground/water level at the Everlasting Swamp (Terry Harrison).

Interestingly, the trees in adjacent and nearby tall woodland and forest vegetation, and even ringbarked (dead) trees, were commonly used by ducks for nesting in the numerous hollows of the mature trees or occupying disused nests of other birds such as Australian Magpies *Cracticus tibicen* or Grey-crowned Babblers *Pomatostomus temporalis* (Roy Bowling).

Waterbirds as food

Waterbirds were obvious food sources for the small-scale farmers. Unlike much Australian fauna, waterbirds appeared similar to the European food species that were familiar to the settlers. While all waterbird species could be pursued, waterfowl were obvious (and tasty) targets due to their high abundance, close proximity and ease of hunting. Black Swans, Magpie Geese and all the species of ducks were routinely eaten although the Pacific Black Duck *Anas superciliosa* was a staple due to its relatively bigger size and greater abundance (Roy Bowling, pers. comm.). On the Coldstream wetlands at least, there were large mixed flocks of Hardhead *Aythya australis*, Grey Teal *Anas gracilis*, Chestnut Teal *Anas castanea*, Australasian Shovelers *Anas rhynchotis*, Australian Wood Duck *Chenonetta jubata* and "a few" Pink-eared Duck *Malacorhynchus membranaceus*, and, at Everlasting Swamp, Musk Duck *Biziura lobata* (Roy Bowling and Terry Harrison, pers. comm.).

An important accessory in the hunting of ducks, besides the shotgun, was the "duck dinghy" (Figures 5 and 6). This was a flat-bottomed wooden boat approximately 4-5 m long, 1 m wide and 30 cm high (of similar dimensions to the canoes used by local Aboriginal people). These were often camouflaged with branches, with dead ducks or swans mounted on the bow as a decoy, and propelled by the occupants with broomsticks (Roy Bowling, pers. comm.). In tidal areas the dinghies could drift up with the incoming tide and back with the outgoing when often the dinghies would be so full of shot ducks there would be almost no freeboard on the return trip (Terry Harrison, pers. comm.). One shot at ground/water level and one in the air was said to deliver 20 ducks (Roy Bowling, pers. comm.).

The plentiful supply of ducks facilitated commercial hunting operations, and by the 1930s a trade to Sydney markets was established. Hunters were permitted to deliver up to 100 ducks per day per hunter to the receiving merchant. Only Black Ducks were targeted for this food trade although "*occasionally other birds were shot …. one time a shooter fired into what he thought was a flock of ducks and got 44 Eurasian Coots. If he'd known he wouldn't have wasted the shots although they are good to eat*" (Terry Harrison, pers. comm.). The birds were gutted but not plucked and "*packed belly down in a fish basket*", and sent to Sydney by boat where they would fetch two shillings and sixpence [25c] per pair, provided they hadn't gone rotten, a major risk prior to refrigeration. "*There was dozens of fellas in the area shooting. They'd lease their hole in the swamp off whoever owned that particular part of the swamp, maybe pay only £1* [$2] *or so a year, and each duck weighs about two and a half pounds* [1.1 kg], *so you couldn't have gone wrong*" (Terry Harrison, pers. comm.). "Holes" were areas of open water in the wetland, and were favoured locations from which to shoot.

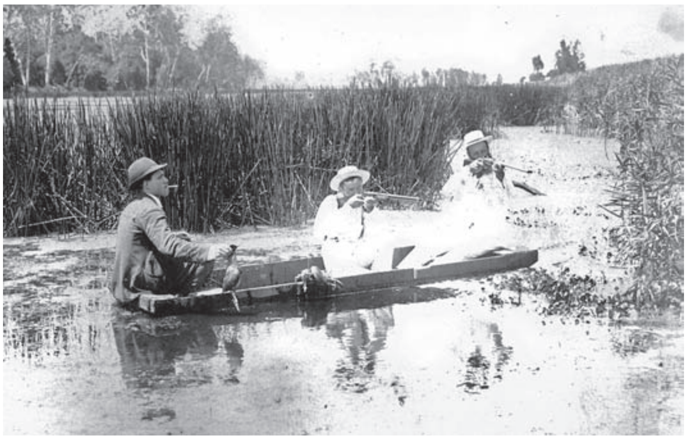

Figure 5. Shooters on the Clarence River ca. 1900, posing for photo. The boatman holds a duck caller in his mouth and a Eurasian Coot *Fulica atra* in his hand. (Possibly on the main river channel near Grafton) (Courtesy of the Clarence River Historical Society)

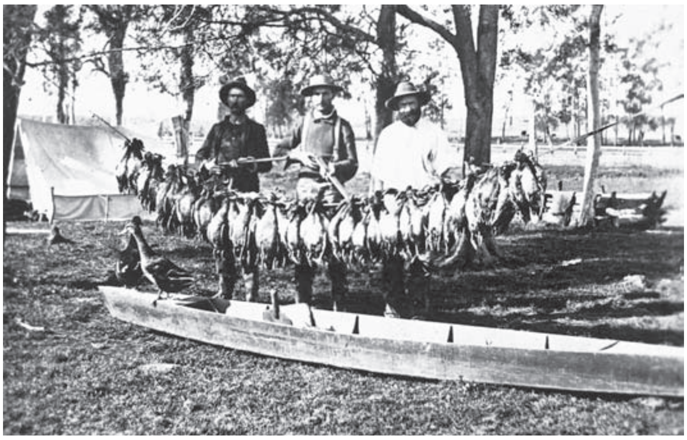

Figure 6. Duck shooters with "catch" ca. 1910 on the Clarence River floodplain (possibly on the Ulmarra or Coldstream wetlands). Note the "duck dinghy" and decoy ducks (Black Duck) on bow. These decoy birds are dead and probably wired into position, although live decoys were sometimes used (illegally) on the water. (Courtesy of the Clarence River Historical Society)

Other species were hunted for food although not commercially. The Purple Swamphen *Porphyrio porphyrio* was favoured for the making of "Redbill Soup" a clear and very tasty soup (Terry Harrison, pers. comm.). Latham's Snipe were said to taste like quail and presented hunters with a challenge due to their unexpected, rapid and erratic flight (Roy Bowling, pers. comm.). The hunting of Magpie Geese is well before living memory; however, anecdotes relate the use of muzzle-loading shotguns. Roy Bowling related how his father would go out on a Friday night "to get a goose for Sunday dinner" while Terry Harrison related his grandfather's brag of how the geese would sit on top of the fence posts where he once shot 11 with one shot!

Waterbirds damaging crops

Waterbirds could also be a nuisance to farmers with Purple Swamphens, Brolgas and Magpie Geese in sufficient numbers to damage some crops, particularly corn (maize). McFarlane (1980 p. 46) described how Brolgas would damage the planted corn:

> *"When the plants* [maize] *appeared above ground the paddymelons* [pademelons, bettongs or wallabies?] *and native companions* [brolgas] *came on the scene. ... The native companions attacked the plants at the early stage only. They would pull the plants out and eat the soft portion of the stems. They were very destructive and one of those birds would soon destroy an acre* [0.4 ha] *of maize."*

Also, much hatred was directed at Black Swans due to the supposition that they ate large amounts of planted and natural pasture that would otherwise be consumed by livestock. In the 1930s, a landholder on the Everlasting Swamp used deer hounds to chase and kill swans, but with little effect (Terry Harrison, pers. comm.). More common was the paid or unpaid duty of farmers' children to go into the wetlands, usually on a pony, armed with a long stick, and smash the swans' eggs in the hope this would decrease the swans' population. Roy Bowling recalled an eight-year-old school colleague arriving at school and proclaiming that *"he'd had a great day … he was still carrying a stick about 8 foot* [2m] *long, and he'd broken 1,000 swan eggs"*. The noise from aggravated swans on the wetland was very loud that night although the swans apparently rebuilt their nests and laid again soon afterwards (Roy Bowling, pers. comm.).

Changing habitat

Descriptions of the wetlands up to the 1950s illustrate how different they were then compared to now. Deep pools up to 10 m deep occurred (where now there is rarely water over 0.5m) and the vegetation was different (as described later). Many wetlands were intricately connected by, and with, creeks and small drainage lines and were subject to tidal influences of varying magnitude depending on elevation of the wetland and the particular tide. Some wetlands had a wetting and drying cycle, for example of about five to seven years on the Coldstream River wetlands (Roy Bowling, pers. comm.). Meanwhile other wetlands had a seasonal variation in salinity depending on the amount of summer dominated rainfall and runoff. Large numbers of ducks would sometimes appear overnight after heavy rainfall.

The floods of 1945, 1946 and 1948 deposited large amounts of silt on the Coldstream River wetlands, 1.2 m with each flood in some channels (as verified by the burying of a fence in each instance) (Roy Bowling, pers. comm.). Following the floods and silt deposition, there was sometimes rapid growth of non-pasture species such as Pale Knotweed (Smart Weed) *Persicaria lapathifolia*, which after decaying in the water led to fish kills (Roy Bowling, pers. comm.), presumably through deoxygenation of the water. Frogs and snakes also appeared more abundant after floods (Roy Bowling, pers. comm.). Conversely, in dry times, fire could be an issue and in 1913 a fire came into the Coldstream wetlands burning *"swamp-oaks* [*Casuarina glauca*], *mulch and peat layer, and was burning for months"* (Roy Bowling, pers. comm.).

Introduced predators

Foxes are said to have arrived in the Everlasting Swamp area in about 1920:

> *"When the foxes came no-one knew what they were …... there weren't any wirelesses or anything, but one old fella said he's an animal similar to a dog but he's got a different sort of call. Then someone shot one because they started killing all his chooks. They never used to keep the chooks and ducks locked up"* (Terry Harrison, pers. comm.).

Prior to arrival of foxes, Straw-necked and Australian White Ibis roosted and nested in large numbers at ground level in the Everlasting Swamp and their eggs were easily collected from their nests. Terry Harrison relayed an amusing anecdote about his father who, as a child before 1920, substituted Ibis eggs for chicken eggs for sale to the merchant trading boat, *"The Fair Trader"*, a vessel that plied the creeks that ran into the Everlasting Swamp. The eggs of the Ibis and domestic chicken are very similar but in one batch an Ibis chick hatched out upon sale to the trader, and he was found out. Ibis no longer roost at ground level presumably as a behavioural response to avoid fox predation.

Waterbirds as "Sport"

> *"Prior to the timber being cleared and when the population* [of Europeans] *was sparse, waterfowl could be bagged in almost any quantity and little skill or energy was required. Game could be had with such ease that it could be scarcely called sport. It was a matter of going to the edge of a swamp under cover of undergrowth and discharging a gun into a flock of ducks or geese. "Sports" at the time was seldom disturbed, and in remote parts of the swamp, never."* (McFarlane 1980 p. 39)

The hunting of waterbirds, like fishing, was also a sport and leisure activity from the early settlement to the late 20th century. Sportsmans Creek, which drains the Everlasting Swamp area, was so named for its ease in obtaining large numbers of ducks and fish.

Recreationally, shooting of waterfowl became an important activity of both locals and tourists, and although this appeared poorly regulated, the floodplain's wetlands continued to support birds in high numbers. Relevant legislation in NSW from 1866 onwards covered the control of hunting and protection of wildlife (Jarman and Brock 2004), but how, or if, this was implemented in the Clarence region prior to the 1950s was not discerned in the current study. By the 1950s there were some public concerns about hunting as recorded by the local Clarence Valley Field Naturalists Club (CVFNC) against *"a petition from the Australian Field Sport and Conservation Society to permit open seasons with bag limits for wild ducks, stubble quail and migratory Jack Snipe* [Latham's Snipe]*"* (CVFNC 1952). Duck shooting remained an important legal recreational activity until the early 1980s, and probably continues clandestinely on a relatively small scale to the present (pers. obs.).

The following quote is insightful and intended as an amusing anecdote about a local identity named De Burgh in about 1900.

> *"When out shooting with the aristocrats he would frequently lie in ambush all night, sometimes in the water, waiting for the wild geese to alight in the lake. At times the water would be frozen but De Burgh would not desert his post and brace after brace of game would be brought down as a reward for his patience and temporary privation."* (McFarlane 1980 p. 42)

Reference to the "aristocrats" suggests there was at this time a distinct social class divide, (possibly reflected in Figure 5 by the difference in dress of the light-suited shooters, and the working attire of the boatman who is holding the dead bird while blowing the duck caller). Referring to the water as "frozen" suggests that it was winter and the water was cold (less than 10°C, but very unlikely to have been actually frozen). In winter, on and near the Clarence floodplain, Magpie Geese have been observed (pers. obs.) roosting either on the ground or in trees in sunny positions, apparently warming themselves perhaps as a thermoregulatory response to their own "privations" of feeding in cold water through the night. Upon the onset of dark they disperse, presumably to floodplain wetlands where they forage through the night. Referring to "brace after brace" being brought down suggests the presence of large numbers of the geese not deterred by either the presence of a hunter or the hunting itself. This is in stark contrast to the small flock of less than 100 very wary geese that now periodically occur and are readily flushed from their locations by human approaches.

A range of factors, such as hunting and wetland destruction, are believed responsible for the serious contraction of range of Magpie Geese from south-eastern Australia by the early 1900s (Nye *et al.* 2007). Use of secure, non-wetland, day-time refuges may also be important in the subtropical and temperate areas of the species' distribution where thermoregulatory behaviour differs from the tropics.

Naturalists

The naturalist James Fowler Wilcox (previously mentioned) was based in South Grafton until his death in 1881. His own on-going business was the collection of biological specimens but he also engaged another naturalist, John MacGillivray, to assist in meeting the requests he received from museums, exhibitions and others in Australia and internationally for wildlife specimens (Nola Mackey, pers. comm.).

John MacGillivray

John MacGillivray (b.1821, d.1867) (Figure 7) was stationed in South Grafton for two years (1864-1866) and a series of letters by him to E.P. Ramsay were published in the *Australian Zoologist* (Iredale 1937). The letters indicate the ease with which he collected waterbird (and other) specimens, sometimes remarking that they could be shot from the window of his house in South Grafton, his collecting aided by the use of his three-barrelled gun (a side-by-side double-barrelled shotgun with a rifle barrel on top). The letters describe the stalking, shooting, preparation and despatch of specimens of "Black-billed Spoonbill" (Royal Spoonbill) *Platalea regia*, Yellow-billed Spoonbill *Platalea flavipes*, Straw-necked Ibis, Australian White Ibis, Stilt (probably Black-winged Stilt), ducks, "little grebe" (Australasian Grebe) *Tachybaptus novaehollandiae*, Magpie Geese, "Jabiru" (Black-necked Stork), White-bellied Sea-Eagle and "small sandpiper" (possibly Sharp-tailed Sandpiper, a dotterel or plover). The letters indicate how relatively abundant were waterbirds, and, as Iredale (1937) remarks *"It must be remembered when reading these letters that they were written in the field without reference to anything save his own memory; written by an active hunter at the end of a day's work, …"*

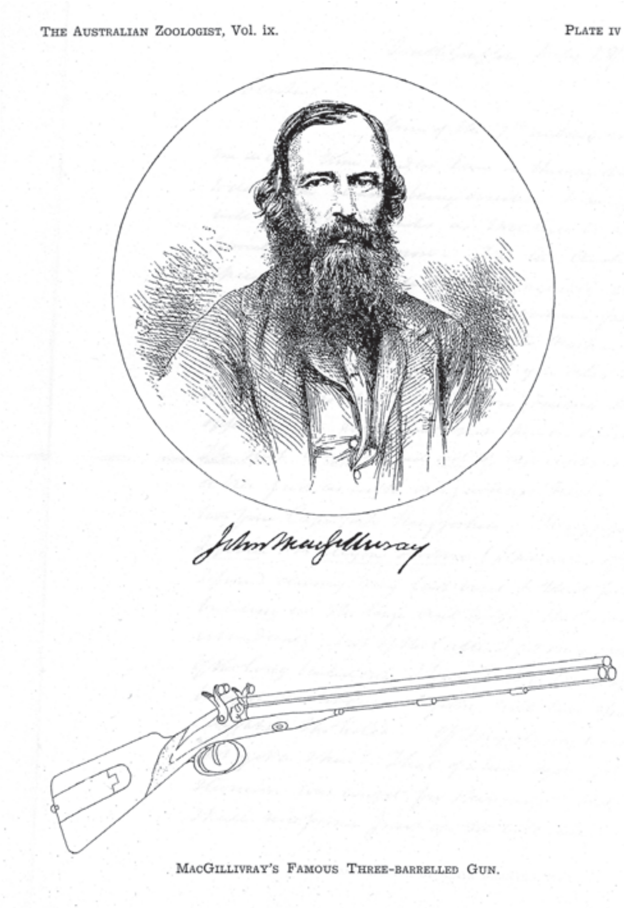
THE AUSTRALIAN ZOOLOGIST, Vol. ix.
PLATE IV
John MacGillivray
MacGillivray's Famous Three-barrelled Gun.

Figure 7. Portrait of the naturalist John MacGillivray and his "famous three-barrelled gun". He was based in South Grafton 1864-66. (From the Australian Zoologist Volume 9, Plate 4) (Iredale 1937).

- July 28th 1865: *"I got also the best straw-necked ibis of many shot since they appeared here"* (Iredale 1937 p. 45)
- August 9th 1865: *"I have just been out taking a turn with the gun. Two ibises were in the paddock and I could have shot them with cartridge from my window."* (Iredale 1937 p. 46)
- June 3rd 1866: [White-bellied Sea-Eagle] *"…. a very grand old female, the skin of which does not exhibit the slightest vestige of blood, grease or dirt, although the bird fell into the swamp in a muddy place and presented a most woeful appearance with blood and mud. I washed it but gave it up for a bad job, but Mrs. Wilcox took up the matter and*

by using soda and hot water restored its respectability most thoroughly. It almost looked as if some magical influence had been employed. I never saw a finer specimen, and I have shot at least a dozen, …." (Iredale 1937 p. 56)

- July 21st 1866:. "*Had a jabiru for dinner a few days ago (skinned of course), and it ate very well, but could not be compared to a kangaroo rat some days previously.*" (Iredale 1937 p. 58)

MacGillivray's remark here that the bird was skinned implies that he had kept the skin for a specimen although it was also common to skin some birds (e.g., Black Swan) prior to eating them as they were not easily plucked (Roy Bowling, pers. comm.).

- December 24th 1865:"*You frequently directed my attention to the* Anseranas melanoleuca [Magpie Goose]. *Yesterday I shot two, one of which was a very fine gander, weighing 6 lb* [2.7 kg]. *So I thought I would skin it, although in a woeful plight from the mud through which I had to chase it and where I very nearly got bogged. My companion – a friend of mine, who gives a grand dinner on Boxing Day – coveted my gander, so I gave him the goose, a very large swan, and a lot of ducks - for we had two horse loads of game, and I might have got more if inclined, but I took little interest in the matter and none in the shooting. By dint of washing with soap and plenty of water and a brush the bird became all right. . . . The tracheae is extremely remarkable on account of its great length and convolutions between the skin and the chest.*" (Iredale 1937 p. 51)

MacGillivray's accounts reveal that collecting waterbird specimens was quite easy, so much so that he often seemed indifferent to the work and, as he remarked, was uninterested in the shooting. This contrasts starkly with his accounts of hunting and collection of macropods, where his enthusiasm throughout the process is conveyed strongly through his text. The tone and content of the letters also highlight prevailing attitudes towards local Aboriginal people, who are only ever referred to as "blacks" and never mentioned by name, even though he appears to have worked closely with many of them on collecting expeditions, and who shot for him, collected the kills, and who often brought specimens, nest and eggs to him.

Naturalists in the 1950s

The Clarence Valley Field Naturalists Club (CVFNC) was formed in the early 1950s by a group of people "*not with a greenie attitude but who just liked being in the bush*" (Leith Martin, pers. comm.). Among the many activities of the club were regular counts of birds in the local area and a study of an egret colony at Gilletts Ridge, part of the Coldstream wetlands. While the bird counts gained official status by being forwarded to the relevant state government department (Chief Secretary's Department), their accuracy was questionable:

> *"Bird surveys were undertaken by 3 or 4 cars, each with 3 or 4 people driving around the Clarence area. The driver would watch the road and the counters would count. At the end of the day the carloads would meet at the pub and tally the results."*

Counts on separate occasions in the 1950s were of up to 219 species and up to 27,000 birds, however "*the totals were not reliable numbers because often the same birds would be counted by separate cars.*" Furthermore one of the club's members was opposed to duck hunting and would falsify the numbers considerably downwards before submitting them (Leith Martin, pers. comm.). The club's general opposition to duck hunting was recorded on several occasions:

- "*It is with regret that the Chief Secretary's Department gazetted an open season for two months which has depleted the waterbird population and dispersed completely out of the district a large variety of timid birds and will take many years to reappear.*" (CVFNC 1957)
- "*With the gazetted open season, early this year again, our water birdlife were again depleted, also many rural landholders having published trespass notices in our local papers to protect their properties. It is hoped more public objections are lodged against any further open seasons.*" (CVFNC 1958)

The Chief Secretary's Department appointed several members of the club as honorary rangers in the 1950s with one of their duties being to look for mutant migratory waders in the Clarence area. This was in response to the possibility that Russia was testing nuclear devices in the Siberian area at the time and affected birds migrating from that area could show the results of radiation! (Leith Martin, pers. comm.).

Prior to its drainage in the 1960s, the Gilletts Ridge wetland supported an egret colony "lousy with birds", where the four egret species, Eastern Great Egret *Ardea modesta*, Intermediate Egret *A. intermedia*, Cattle Egret *A. ibis*, and Little Egret *Egretta garzetta*, roosted and nested in a closed stand of Broad-leaved Paperbark *Melaleuca quinquenervia* trees. The CVFNC undertook a banding project there, and in the 1959-60 summer 78 birds of the four species were banded (CVFNC 1960).

> *"To band birds we put a ladder up a tree to the nest, put an open fishing line around the top of the nest and wait for the bird to land, then pull the line tight with the fishing rod and reel in the bird and band it."* (Leith Martin, pers. comm.).

The CVFNC (1960) reported that Cattle Egrets occurred at Gilletts Ridge in "the early spring of 1953" with 13 of their nests observed at that time. These observations and those of their presence there in November 1954 (Goddard 1955) represent some of the earliest records of the species in southern Australia during its rapid expansion in distribution from northern Australia over the previous 20 years. Also of interest was the description of Water Hyacinth *Eichhornia crassipes* covering the water at the wetland. This plant remains an intrusive water weed to the present, and was reported to have been introduced to the local wetlands in nearby Swan Creek in the 1850s so that its flowers would add colour to the landscape (Bawden 1979).

Flooding and Drainage

The floodplain was settled upon and developed with little appreciation of the local influence of floods and tides. The frequent flooding was problematic for floodplain agriculture, and for urban areas (Figure 8). Not only

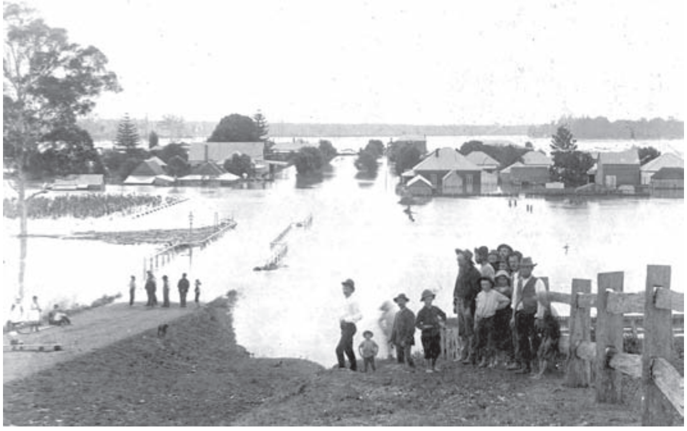

Figure 8. South Grafton (looking west along Through Street) during the "Great Flood of 1890" flooding homes, crops and roads. Water reached a height of 7.8m in Grafton, the highest recorded from 1839 to the present. (Courtesy of the Clarence River Historical Society)

were floods damaging events, but flooded areas could remain inundated for extended periods, from months to over a year after a flood, often excluding farming on otherwise suitable land. Conversely, between flood events, the saline water of the estuary could be pushed up on high tides to advance onto otherwise dry land, killing crops in a single inundation.

As the types of crops and the sites of their growing became more institutionalised, based on established markets, and handling and processing facilities (such as sugar mills and butter factories), farmers wanted more certainty that their small holdings would support their endeavours, in particular that the water levels and the salinity of this water could be controlled, or at least predicted.

Drainage Unions (or Trusts) were formed by groups of farmers with shared interests in controlling or managing a common waterway. Forming as early as the 1860s at Lawrence and Southgate (Nola Mackey, pers. comm.), these groups initially implemented simple schemes, such as boarding up channels to control water flows, and later undertook more ambitious projects such as constructing drains, levees, weirs and floodgates.

> *"For a number of years the farmers were rather shy of drainage schemes owing to some extent to the outlay necessary but chiefly to the uncertain benefits likely to be derived. .... Now however circumstances have changed as the swamp lands are used for dairy farming and if the water can be got away in one month, which previously took six months, the benefit derived is easily seen."* (McFarlane 1980 p. 45)

Schemes to alter hydrological flows on the floodplain were common up to the 1950s where most works consisted of shallow drains that removed surface water and left land exposed to at least some tidal influences and flood events. Many of these early drains were dug by hand with labourers using picks and shovels, for example as labour creation schemes in the 1930s (Ros Ryan, pers. comm.), although a steam shovel assisted in the construction of the Avenue Drain near Swan Creek in the 1920s (Roy Bowling, pers. comm.).

It is difficult to gauge the impact that these projects had on waterbirds but populations of most species remained high enough through this period to support the ongoing hunting. The exception was the Magpie Goose whose range and numbers had already declined dramatically in south- eastern Australia (Nye *et al* 2007).

The Everlasting Swamp

The Everlasting Swamp was so named because it was never dry, being either fresh, saline or brackish courtesy of numerous small watercourses connecting the wetland through Sportsmans Creek to the Clarence. However, with a desire to have the area's wetlands permanently fresh, landholders constructed a low weir across the mouth of the Little Broadwater in 1910 (which was rebuilt in the late 1950s). They then started to consider the construction of a weir across Sportsmans Creek in about 1916, as a tidal barrier to keep saline water from extending upstream. The Sportsmans Creek Drainage Union formed in 1925 and then financed and constructed a weir in 1927. With poor foundations it was washed away upon the next flood but was rebuilt using concrete with lead seals dove-tailed into the concrete, and remains in place to the present.

Prior to the construction of the Sportsmans Creek weir, fish passage was unrestricted from the Clarence into the wetlands and *"fish would go up creek often pursued by dolphins, 20 or so would push fish up into the swamp. One night two fishermen got two jewfish, a mile above the weir, both about 90 pounds* [~40 kg]. *All the other fish, bream and flathead, garfish, prawns … everything you could think of ….. and fishermen would get all these from the swamp"* (Terry Harrison, pers. comm.).

An immediate impact of the weir was not only the loss of fish passage, but also mangroves, which formed avenues along and over the subsidiary watercourses, and which died once the circulation of water stopped. Interestingly, there were very few flood events in the early 1900s (up to 1921) and the prolonged periods of higher salinity water in the wetlands may have inspired landholders to seek its exclusion from their land. Possibly, the very frequent flooding that began in 1945 masked the effects of the construction of flow barriers in and around Sportsmans Creek, keeping the wetlands wetter than they were previously, and less saline.

A desire for more drainage

By the early 1900s it was obvious to many landholders that agricultural productivity could be increased if flows of water on and off their lands could be better controlled using more sophisticated and coordinated methods:

[~1910] *"Drainage Trusts have been formed and there is every indication that extensive drainage works will be undertaken and in view of the rich character of the land there is no apparent reason why they should not be successful."* (McFarlane 1980 pp.45-46)

Such methods were eventually deployed some 50 years later when, after the Second World War, new technology, increased capital, and a supply of ex-soldiers trained on heavy vehicles, became available.

Landscape Change II - Flood Mitigation

From 1945, due to higher seasonal rainfall, the frequency of major flood events increased, becoming almost an annual event for the next 15 years (Clarence Valley Council 2007). Furthermore these major floods were interspersed with smaller flood events referred to as "nuisance floods" (Terry Harrison, pers. comm.) that, while not disrupting urban centres, still flooded agricultural land disrupting cropping and grazing. This "new" flood regime was costly in terms of damage to urban and agricultural infrastructure, and unpredictably disrupted established farming and grazing practices.

Societal trends in Australia at this time of post-war economic growth, such as population growth, political will, industrialisation and the availability of large earthmoving machinery, along with a desire to increase agricultural capacity, all facilitated the institutionalising of flood control and land drainage. Schemes to facilitate this were referred to, somewhat euphemistically, as "Flood Mitigation" and a local government authority, the Clarence River County Council (CRCC) was formed in 1959 with this purpose. Some works were undertaken prior to this, but the majority of large works were undertaken from 1963 to 1980, based on studies and reports of the NSW Public Works Department (Mitch Tulau, pers. comm.). During this time, the CRCC methodically constructed large drains (Figure 9) and installed floodgates at various locations across the floodplain, and later constructed levee walls to protect the urban centres of Grafton, South Grafton, Ulmarra and Maclean.

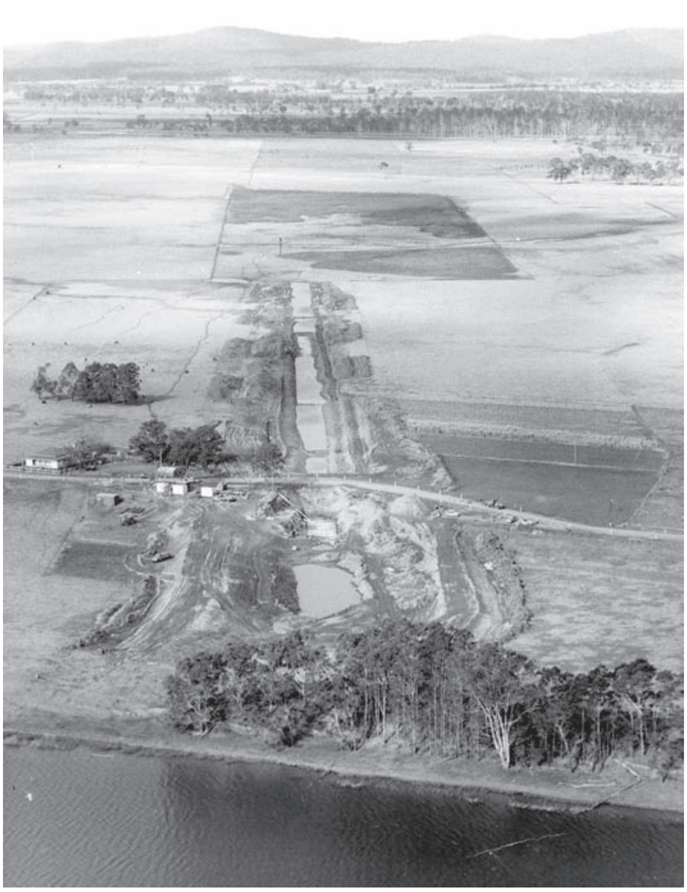

Figure 9. Construction of the Cowper flood mitigation drain in the 1960s, to drain the northern area of the Coldstream-Ulmarra wetlands into the Clarence River. (Courtesy of Clarence Valley Council)

> *"A lot of people probably say "OK, right, leave the swamps the way they are" … but these freshwater swamps, ... they're non-productive, … unless you go in for wildlife, but that's not my game." " My main interest was draining the land. I'm interested in drainage."* (Ori Pastega, Drainage Foreman 1960s, Clarence River County Council, in Lucas 1999)

The impact of this drainage on local waterbirds was immediate and dramatic. The large flocks of ducks and swans disappeared from wetlands where previously there had been thousands (Roy Bowling, pers. comm.). Less abundant, but often-observed species such as the Musk Duck on the Everlasting Swamp also disappeared:

> *"By the time the drains were finished all birdlife just stopped, stone dead, straight away. Every deep hole in the corner of the creek from the weir upstream right up to the railway line and right out into the middle of the swamp had a family of musk duck, they'd make a display of splashing water every afternoon. They built a nest in amongst the reeds, I suppose the reeds have gone. They'd make a little entrance where there was a bit of higher ground and they'd put a roof, pull the reeds down and make a roof over their nest and lay 3-4 eggs in the mound. The male had the big gill things ... I haven't seen them for 45 years."* (Terry Harrison, pers. comm.)

Similarly, the Cotton Pygmy-goose *Nettapus coromandelianus*, now endangered in NSW (*Threatened Species Conservation Act 1995*), was often observed prior to drainage but now is rarely seen. One bird sighted at Swan Creek in 2007 was the first sighting in the area for many years (Eric Wheeler, pers. comm.).

Increased agricultural productivity

Flood mitigation was pursued with vigour and haste with a grand vision of increasing agricultural productivity:

- *"Flood mitigation was a real challenge in those days. When I came here, the County Engineer took me for a flight over the area and he says "There it is". He said "Do you think you'd be interested in doing some of this work here, tidying up the area." I said "My word!" We worked up 'til 9 or 10 p.m., no overtime, just for the sake of doing it. After seeing from the air with these great huge areas of water, I thought if you can get rid of that water then you actually get into production, and this is what's happening today"* (Ori Pastega, in Lucas 1999)
- *"My great-great grandfather came here and cleared the land and went through hard times to establish himself. And* [now] *I'm producing more per acre than any of the previous generations."* (John Ensby, in Lucas 1999)

The flood mitigation scheme did increase agricultural productivity on many farms, most noticeably, on the lower floodplain. The drainage of land and the interception of tidal flows facilitated a 1.5-fold increase in the area planted to sugar cane, and the continued existence of the local sugar industry is now dependent upon these flood mitigation works (Clarence Valley Council 2003).

Decreased agricultural productivity

While many landholders welcomed flood mitigation, many others were ambivalent, but at the time, only a few were opposed. The scheme was well intentioned, with the aim of constructing and maintaining mitigation works for the general benefit of local communities (Mitch Tulau, pers. comm.). The good intentions were largely unchallenged, so it was not until after the event that people at large could reflect upon it. In hindsight many landholders could see the disadvantages:

- *"It wasn't flood mitigation, it was land reclamation!"* (Geoff Richards in Lucas 1999)
- *"Flood mitigation made me decide to move off the land. There was a low swamp and I had lucerne along side it and used to cut lucerne three feet high and when they drained it that went down to half that height. It was depending on the water."* (Athol McPhee, in Lucas 1999)
- *"The carrying capacity on these swamps is not as good as it used to be. In 1953, straight out from where I live – 1000 acres there, a little bit of it's not swamp, in the drought Jo Priest* [owner] *had 800 cattle and 160 horses, and there was grass going to waste!"* (Roy Bowling, pers. comm.)
- *"A lot of the swamps were overdrained, better off left as they were, at least they used to grow a bit of swamp couch and that sort of stuff in them times. …. Well, this big swamp out the back here, Everlasting, a few thousand acres, that only grows bulrushes now. This drain is just full of acid sulphate. They dug it below tide level. And they're trying to blame the farmers for the acid sulphate that goes into the river and that's a lot of bullshit. These drains should have been dry. If it drains it should drain. It's not a bloody canal, you don't want to put boats in it. A drain that was going to be two foot six* [75 cm] *ends up five foot deep* [150 cm]*!"* (Kevin Johnson, in Lucas 1999)

The disapproval that these farmers expressed in the above quotes reveals some important points:

a. Some farmers, particularly graziers, disapproved of, and were adversely affected by, the CRCC drainage and preferred the wetlands undrained, or with only shallow drains;

b. Drainage brought about vegetation changes within wetlands, generally to less palatable and less nutritious pasture species, most notably from Water Couch *Paspalum distichum* to Soft Rush (Spike Rush) *Eleocharis* spp. and Common Couch *Cynodon dactylon*. These changes occurred over areas of several thousand hectares of wetlands;

c. Deep drains intercepted the underlying potential acid sulphate soils, which upon oxidising became actual acid sulphate soils, and then leached acid discharges into waterways including wetlands, creeks and the river, leading to diseases and death of commercial and non-commercial fish species;

d. The deep drains are often not dry but have formed relatively large areas of water, either singly or collectively, and are therefore potentially important local waterbird habitat.

What was lost?

The negative effects of flood mitigation were obvious to the field naturalists who documented their concerns:

> *"The major project of the Club has been the investigation of the problems connected with the development of flood mitigation. ... we have been successful in arousing public interest and in provoking questions and criticisms. ... the Executive met officers of the CRCC for discussions ...."* (CVFNC 1966)

The CRCC unofficially requested that the CVFNC not publicise their concerns about the effect of flood mitigation on birds as it might affect funding allocations for the following year (Leith Martin, pers. comm.).

> *"The development of flood mitigation work and its relationship to the diminution of wetlands is a matter of continuing concern to us."* (CVFNC 1967)

By 1967 the CVFNC was openly discussing the preservation of wetlands for waterbirds and corresponded with state government about establishing sanctuaries, while acknowledging that purchase from private landholders would be necessary. However, it would be almost another 40 years before a state-managed conservation area for this purpose was declared in the region.

Loss of a sport and recreation resource

As the ease and accessibility of duck-shooting sites dwindled, the recreational shooters became more desperate, and prior to permits no longer being issued, the shooting became erratic with shooters targeting any sorts of birds and coming into increasing conflicts with landholders to access sites (Roy Bowling, pers. comm.). Once given access, shooters often built tots, i.e. wooden structures that served as hides and platforms to shoot from in the wetlands. One landholder remarked that there were an amazing number of lightning strikes following construction of the tots, as they were mysteriously burned soon after the hunters had left (John Buchanan, pers. comm.).

Solastalgia

The impact of flood mitigation on wetlands was most obvious for those who revisited the area after long periods of absence. "Solastalgia" is a syndrome defined as "a lack of solace in one's home environment caused by the impact of negative human-made environmental change" or "a homesickness you have when you are still at home" (Albrecht 2005, 2006; Higginbotham *et al.* 2006). Local residents (Glen McCarthy and Terry Harrison, pers. comm.) described accompanying older relatives to visit wetland areas where they (the relatives) used to live "*but they cried when they saw what happened as a result of the drainage*". Feeling hopeless in relation to the environment is typical of the solastalgia syndrome. For example, many people can recall in their younger lives how easy it was to catch ducks (Janette Bowles and Bev Willis, pers. comm.). For them, the loss of water and waterbirds from the wetlands is an emotional disturbance.

The Present

General

The abundance of waterbirds on the floodplain now appears consistently lower compared to the pre-drainage landscape. Large numbers of ducks and swans have not occurred on the fresh and seasonally-fresh wetlands for over 40 years, although on The Broadwater, an estuarine lake, counts of 10,000 and 5,000 Black Swans were made in 1983 and 1991 respectively (Greg Clancy, pers. comm.), but they did not nest there. Nests of Black Swans now number in single figures at any given wetland and are not in close proximity to one another (pers. obs.). A large flock of ducks on the Clarence would now be considered to consist of 500 to 1,000 birds and flocks of Grey Teal, Pacific Black Duck and Plumed Whistling-Duck *Dendrocygna eytoni* are occasionally observed in such numbers, as either single-species or mixed-species flocks (pers. obs.). Flocks of ibis, spoonbills or egrets can be of 50 to 200 birds per species although there are few local sites for these colonial birds to nest. The *Melaleuca* swamp at Lawrence is the main local site for such nesting, although it is dominated, at least numerically, by Cattle Egrets.

Bird watching is a hobby enjoyed by many people locally, nationally and internationally, and is an important component of the ecotourism industry. This indicates that the protection and restoration of waterbird habitat is a legitimate economic concern, if indeed it needs to be justified in this way. A local group, the Clarence Valley Birdos, are active in observing and promoting the cause of bird conservation locally and elsewhere, and have produced a guide (a pamphlet) for observing birds in the local area (Clarence Valley Birdos 2006).

Less abundant species are now a point of interest if not legitimate conservation concern. From the 1980s onwards up to 100 Magpie Geese have been regularly observed in the area (pers. obs.; Clancy 1985) although not continuously through the year. The previously mentioned occurrence of a single Cotton Pygmy-goose in 2007 (at Swan Creek) was the cause of much excitement for local birdwatchers. Brolgas and Comb-crested Jacanas are usually observed in numbers less than 10 at any given wetland although counts of 100 and 20 respectively have been made in recent years (pers. obs.). Black-necked Storks may have changed little in abundance from the 1800s to the present (Greg Clancy, pers. comm.) given their naturally low densities. Importantly, the relationships of abundance and distribution to human-induced environmental changes need to be understood.

Changes to the hydrological regimes (salinity, depth, duration) and vegetation within wetlands can influence the distribution and abundance of waterbirds. Of particular interest now on the Clarence floodplain is how these changes and any ameliorative management strategies can affect species that are threatened in NSW (e.g., Brolga, Magpie Goose, Comb-crested Jacana and Black-necked Stork) (*Threatened Species Conservation Act 1995*), or are of conservation interest due to international conventions and treaties such as the Japan-Australia Migratory Bird Agreement (JAMBA), China-Australia Migratory Bird Agreement (CAMBA) and Republic of Korea-Australia Migratory Bird Agreement (RoKAMBA) (*Environment Protection and Biodiversity Conservation Act, 1999*).

The floodplain remains a mostly agricultural landscape, with agriculture, predominantly sugar and beef, contributing about $100 million to the local economy annually (Clarence Valley Council 2006). Agricultural holdings on the floodplain are larger than the average 40-acre holdings of before the 1950s, but they economically support far fewer people per unit area (Ken Woodward, pers. comm.). Landholders' interactions with waterbirds are also far less, as now the birds are not a food source, at least not legally. Waterbirds have aesthetic value for many landholders, although Australian Wood Ducks are sometimes considered to be a nuisance by those who believe that by congregating at farm dams they can pollute the water there (Ken Woodward, pers. comm.).

The floodplain is bisected by a major interstate highway (Pacific Highway) linking Sydney and Brisbane, with a new route now being planned which will entail the construction of an even bigger road and occupy additional land on the south and east of the floodplain, although not necessarily impacting wetlands directly. The region is also subject to ongoing urban growth from existing centres, such as Grafton, Maclean, Lawrence and Yamba.

A review of the history reveals the obstacles to ecological restoration in the Clarence floodplain. The environmental and social changes (summarised in Table

Table 1. Human activities affecting waterbirds and their habitat on the Clarence River floodplain (based on historical, anecdotal and personal observations).

Human activity	Hunting	Direct Disturbance (plough / burn)	Shallow Drainage	Diversion (channels/ levees)	Deep Drainage	Wetland Restoration	Waterbird Conservation Area
ERA							
Pre-European	•	•(?)					
Early European: to 1920	•	•	•				
European 1920 to 1945	•	•	•	•			
1945-1980	•	•	•	•	•		
1980-1997		•	•	•	•		
1997-2005		•	•	•	•	•	
2005-present		•(<)	•	•	•	•(>)	•(>)

(A dot point (•) indicates that the activity continues to have effects; arrows indicate if the activity is increasing (>) or decreasing (<), and (?) indicates the activity was possibly undertaken but unknown.)

1) that have occurred have been so great as to make restoration to some historical point prohibitively expensive, if not impossible, at many sites. Clearing of vegetation, siltation, ground subsidence, land subdivision, drains, levees, agricultural systems, domestic livestock and introduced predators have caused fundamental ecological paradigm shifts that are not easily reversed, or even possible to reverse (Chrisy Clay, pers. comm.). Furthermore, many community members may not desire restoration for reasons as diverse as concerns over their economic livelihoods to a dislike of mosquitoes that may appear with additional water on the land. Nonetheless, it is within this altered landscape, and with current management practices, that any restoration efforts need to be applied.

By 1969 about 60% of high-value waterbird habitat of fresh and seasonally-fresh marshlands on the far north coast of NSW had been destroyed by drainage for flood mitigation (Goodrick 1970) and, by 1985, 92% of the Clarence wetlands were considered degraded (Pressey 1987). The substantial decline in waterbird numbers appears largely due to this draining and gating of these wetlands since 1960 (Broome 1978) although this and similar impacts have been common on floodplain wetlands throughout Australia (Kingsford and Norman 2002). (Table 2 presents indicative estimates of changes in waterbird numbers for the species present in these wetlands.) More so, with rainfall a driver of waterbird distribution and abundance (Kingsford *et al.* 1999), extra regional influences such as floods and drought may also affect waterbird populations locally.

Table 2. Frequently recorded waterbird species of the fresh and seasonally fresh wetlands of the Clarence River floodplain: indicative abundance before and after floodplain drainage of the 1960s (based on historical, anecdotal, personal observations and unpublished data from current research). (Estimate of maximum abundance: U = unknown; 0 = 0; 1 = 1 to 10; 2 = >10 to 100; 3 = >100 to 1,000; 4 = >1,000 to 10,000; 5 = >10,000) (Listed refers to listing under the NSW TSC Act 1995, or as a migratory species under Australian EPBC Act 1999.)

Species		Other names used locally	Estimated maximum abundance at any wetland		Comments: conservation status; historical use; agricultural significance
			Pre drainage	Post drainage	
Podicipedidae					
Australasian grebe	*Tachybaptus novaehollandiae*		U	1-2	
Pelicanidae					
Australian pelican	*Pelecanus conspicillatus*		U	1-2	
Anhingidae					
Australasian darter	*Anhinga novaehollandiae*		U	1	
Phalacrocoracidae					
Great cormorant	*Phalacrocorax carbo*		U	1	
Pied cormorant	*Phalacrocorax varius*		U	1	
Little black cormorant	*Phalacrocorax sulcirostris*		U	1	
Little pied cormorant	*Microcarbo melanoleucos*		U	1	
Ardeidae					
Cattle egret	*Ardea ibis*		0, 3+	3-4	Arrived in 1950s, high numbers at nest sites Listed: epbc act
Eastern great egret	*Ardea modesta*		U	2	Listed: epbc act
Intermediate egret	*Ardea intermedia*		U	2	
White-necked heron	*Ardea pacifica*	Pacific heron, bachelor crane	U	1-2	
Little egret	*Egretta garzetta*		U	1	
White-faced heron	*Egretta novaehollandiae*	Blue crane	U	2	
Nankeen night heron	*Nycticorax caledonicus*		3	1	
Ciconiidae					
Black-necked stork	*Ephippiorhynchus asiaticus*	Jabiru	U	1	Listed: endangered
Gruidae					
Brolga	*Grus rubicunda*	Native companion	U	1-2	Listed: vulnerable
Threskiornithidae					
Glossy ibis	*Plegadis falcinellus*		U	1-2	
Australian white ibis	*Threskiornis molucca*		3-4	2-3	

Species		Other names used locally	Estimated maximum abundance at any wetland		Comments: conservation status; historical use; agricultural significance
			Pre drainage	Post drainage	
Straw-necked ibis	*Threskiornis spinicollis*		3-4	2-3	
Royal spoonbill	*Platalea regia*		U	2	
Yellow-billed spoonbill	*Platalea flavipes*		U	1	
Anseranatidae					
Magpie goose	*Anseranus semipalmata*	Wild goose, pied goose	3-4	1-2	Listed: vulnerable common food species until early 1900s, then absent until early 1980s
Anatidae					
Black swan	*Cygnus atratus*		5	2-3	Food species before 1960, particularly pre-flight sub-adults: skinned, as not easily plucked. Culled due to competition with cattle for pasture
Plumed whistling-duck	*Dendrocygna eytoni*		U	2-3	
Pacific black duck	*Anas superciliosa*		5	2-3	Most common food and sport species until 1980s
Mallard	*Anas platyrhynchos*		U	1	
Grey teal	*Anas gracilis*		5	2-3	Common food and sport species until 1980s
Chestnut teal	*Anas castanea*		U	1-2	
Australasian shoveler	*Anas rhynchotis*		U	1-2	
Pink-eared duck	*Malacorhynchus membranaceus*		U	1-2	
Hardhead	*Aythya australis*	Copperhead	U	1-2	
Australian wood duck	*Chenonetta jubata*	Maned duck (goose)	U	1-2	More abundant away from wetlands
Cotton pygmy-goose	*Nettapus coromandelianus*		U	1	Listed: endangered one sighting in 2007
Musk duck	*Biziura lobata*		2	1	
Accipitridae					
Wedge-tailed eagle	*Aquila audax*		U	1	
Swamp harrier	*Circus approximans*		U	1	
White-bellied sea-eagle	*Haliaeetus leucogaster*		U	1	
Whistling kite	*Haliastur sphenurus*		U	1	
Eastern osprey	*Pandion cristatus*		U	1	
Jacanidae					
Comb-crested jacana	*Irediparra gallinacea*	Lilly-walker, lilly-trotter lotus bird, jesus bird, pirate bird	2-3	1	Listed: vulnerable
Rallidae					
Buff-banded rail	*Gallirallus philippensis*		U	1	
Dusky moorhen	*Gallinula tenebrosa*		U	1-2	
Purple swamphen	*Porphyrio porphyrio*	Red-bill	U	1-3	Valued as food item: 'red-bill soup' which is clear and tasty
Eurasian coot	*Fulica atra*		U	2-3	
Charadriidae					
Black-fronted dotterel	*Elseyornis melanops*		U	1	
Red-kneed dotterel	*Erythrogonys cinctus*		U	1	
Pacific golden plover	*Pluvialis fulva*		U	1	

Species		Other names used locally	Estimated maximum abundance at any wetland		Comments: conservation status; historical use; agricultural significance
			Pre drainage	Post drainage	
Banded lapwing	*Vanellus tricolor*		U	1	
Masked lapwing	*Vanellus miles*	Spur-winged plover	U	1-2	
Scolopacidae					
Sharp-tailed sandpiper	*Calidris acuminata*		U	1-2	
Bar-tailed godwit	*Limosa lapponica*		U	1	Listed: epbc act
Latham's snipe	*Gallinago hardwickii*	Japanese snipe, jack snipe	3	1	Listed: epbc act. Valued as delicious food species (tastes like quail), and for sport shooting (rapid zig-zag flight)
Common greenshank	*Tringa nebularia*		U	1	Listed: epbc act
Marsh sandpiper	*Tringa stagnatilis*		U	1	Listed: epbc act
Recurvirostridae					
Black-winged stilt	*Himantopus himantopus*	Pied stilt, dog snipe	U	1-3	
Laridae					
Whiskered tern	*Chlidonias hybrida*	Marsh tern	U	2	
Crested tern	*Sterna bergii*		U	1	
Caspian tern	*Hydroprogne caspia*		U	1	
Gull-billed tern	*Gelochelidon nilotica*		U	1	

The changes to wetlands have not only greatly reduced the total area of wetland habitat for waterbirds, but dramatically altered the hydrological dynamics of the remaining wetlands. Functional waterbird habitat also changed. For example, ground subsidence has occurred in some wetlands following extended drying after drainage, where ground levels have dropped by up to 30 cm (Matt Foley, pers. comm.). The drier ground in and around wetlands has also caused a gradual encroachment of taller vegetation into wetlands as evidenced by the advance of *Melaleuca quinquenervia* trees into some areas that were previously marshes (Johnston *et al.* 2003). Furthermore, the local Clarence Landcare group is encouraging the planting of "local native" trees on sugar cane farms (Clarence Landcare Inc. 2007) at sites not impacting the growth of the cane. The growth of these trees might be enhanced by soil conditions less saturated compared to those prior to drainage.

Restoration

Until recently, most wetlands on the floodplain that can be restored were, and still are, privately owned, and most are used for agricultural purposes. Restoration efforts, then, need to allow for the economic imperatives of the agricultural enterprises, and this has been limited to drain management on most sugar cane areas where flooding of land is anathema. There is greater acceptance of the inundation of grazing land where water stimulates the growth of pasture, in particular the naturally-occurring Water Couch. NSW government agricultural scientists are currently evaluating the grazing potential of long-term wet pasture (Phil Hirst, pers. comm.).

The Clarence Floodplain Project

The Clarence Floodplain Project began in 1997, as an initiative of local government, to improve management of the floodplain, flood control structures (e.g., floodgates, weirs and levees), water quality and habitat in cooperation with landholders, industry, community and government (Clarence Valley Council 2007). The project's efforts since 1997 have resulted in the modification of 73 of the 494 floodgates (14.7%), and have been highly successful in decreasing the formation of acid sulphate soil in and around flood mitigation drains, and increasing hydrological connectivity, thereby increasing fish passage (Kroon and Ansell 2006). An important factor in the project's success was that landholders were actively operating and monitoring the flood-control structures according to previously agreed plans of management. The effect of the project on waterbird habitat is yet to be evaluated (Smith, current research), although any increases in inundation of drained wetlands are likely to be beneficial to waterbirds (Figure 10).

The Everlasting Swamp State Conservation Area

In 2005 the NSW government purchased an area of approximately 450 ha which was later proclaimed the Everlasting Swamp State Conservation Area. This is the single largest wetland reserve on the floodplain, and is first state government managed local area of wetland supporting potentially high-quality waterbird habitat. While the reserve area is only a part of the whole wetland, and the habitat is particularly degraded by the construction of drains and levees (pers. obs.), it is not beholden to the economic

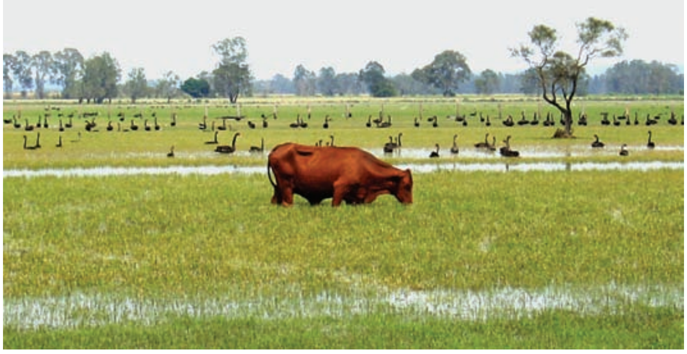

Figure 10. Cattle grazing and Black Swans at Little Broadwater, 2003. The Clarence Floodplain Project has included strategies to reintroduce water onto drained wetlands on private land, benefiting livestock graziers and waterbirds. (Courtesy of Clarence Valley Council)

considerations of agriculture, and so there is much scope for restoration with the primary purpose of waterbird conservation. The managers here need to evaluate issues of restoring not only foraging habitat for resident, nomadic and migratory species, but also breeding habitat for some species. A major management consideration, however, is the effect of hydrological management on neighbouring agricultural landholders (John Kennedy, pers. comm.).

Knowledge Gaps

Changes to the hydrology of wetlands through manipulation of hydrologic control structures, such as floodgates, are concerns for threatened species management. Specific management approaches may favour some species, but disadvantage others. Natural resource managers now require more sophisticated knowledge of changes in the diversity, abundance and composition of bird communities in response to floodgate manipulation to assist local wetland bird conservation. Furthermore, local declines and increases in waterbird abundance can be due to a range of extra-regional factors such as drought, flood and water management. When these factors are considered, along with the nomadic behaviour of many species, it is obvious that there are many vagaries with which local natural resource managers must contend when predicting the value of restoration works to waterbirds.

Climate Change

Anthropogenic climate change and associated global warming and sea-level rise are widely predicted to cause massive social and ecological changes in the 21st century (Flannery 2005; Gore 2006). The effects of climate change on low-lying wetlands and waterbirds on the Clarence floodplain (and elsewhere) will be profound. Apart from the possible social changes affecting local land use and management, the ensuing altered hydrological regime could be expected to deliver another major change of landscape. Local ecologists, farmers, graziers and natural resource managers now seem mindful of the possible local effects of rapid global warming. These professions have witnessed and overseen the draining of the landscape, and then, attempts to restore it, demonstrating that they are capable of creating, and responding to, landscape change. However, climate change is likely to be a much greater challenge. An historical review that may be conducted in the 2060s comparing the natural resource management strategies then current, with those of the 1960s and 1860s, will be interesting, to say the least.

Conclusions

Historically, there has been a dramatic decline in the numbers of waterbirds that are regularly present on the Clarence River floodplain. Despite the recognition of the need to conserve and restore wetlands and waterbird habitat, the increase in overall waterbird habitat on the floodplain since flood mitigation has been minor at best, with only small increases in areas of functional habitat available for threatened species. Such increases are physically limited by almost irreversible ecological disturbances that have occurred on the floodplain, such as changes to the vegetation of wetlands and surrounding areas, ground subsidence in some wetlands following drying, siltation in other wetlands following floods, background agricultural land-use practices, landform changes through levees and drains, and the permanence of infrastructure such as roads, bridges, weirs and human settlements.

The creation of waterbird habitat has been seen until now as secondary or incidental to the outcome of restoration projects, mainly because of the priority of economic considerations when undertaking these projects on agricultural land, but also because of the lack of knowledge available about the creation of functional waterbird habitat. Ongoing and future restoration projects, if they are to assist waterbird conservation on the Clarence floodplain, need to incorporate an appreciation and understanding of how the floodplain has altered and the consequences of future hydrological changes.

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